Effect of Performance Time of the Semi-Occluded Vocal Tract Exercises in Dysphonic Children

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Summary: Objective. This study aimed to verify the effects of execution time on auditory-perceptual and acoustic responses in children with dysphonia completing straw phonation exercises.

Study design. A randomized, prospective, comparative intra-subject study design was used.

Methods. Twenty-seven children, ranging from 5 to 10 years of age, diagnosed with vocal cord nodules or cysts, were enrolled in the study. All subjects included in the Experimental Group were also included in the Control Group which involved complete voice rest. Sustained vowels (/a/e/ɛ/e/) counting from 1 to 10 were recorded before the exercises (m0) and then again after the first (m1), third (m3), fifth (m5), and seventh (m7) minutes of straw phonation exercises. The recordings were randomized and presented to five speech therapists, who evaluated vocal quality based on the Grade Roughness Breathiness Asthenia/Strain Instability scale. For acoustic analysis, fundamental frequency, jitter, shimmer, glottal to noise excitation ratio, and noise parameters were analyzed.

Results. Reduced roughness, breathiness, and noise measurements as well as increased glottal to noise excitation ratio were observed in the Experimental Group after 3 minutes of exercise. Reduced grade of dysphonia and breathiness were noted after 5 minutes.

Conclusion. The ideal duration of straw phonation in children with dysphonia is from 3 to 5 minutes.

Key Words: Voice–Dysphonia–Child–Speech therapy.

INTRODUCTION

Nodules are the main cause of vocal alterations in children.[1] However, the prevalence of these lesions in children with vocal complaints is divergent, ranging from 28.6% to 94.0%, followed by epidermoid cyst and polyps.[1–5] In most cases, speech language therapy is indicated for these children.[1,3–5] The literature suggests that this treatment favorably affects voice quality[6–11] accompanied by improved acoustic measures (*jitter%* and *shimmer%*) as well as fundamental frequency (F0)[8–10] and reduced overall degree of dysphonia and vocal roughness.[6,10] These changes are also associated with positive favorable impact on the physical, functional, and emotional domains of the Voice Handicap Index.[7,11] However, recommendations regarding the prescription of voice therapy exercises remain inconsistent.[12] In contrast, for example, The American College of Sports Medicine's Guideline describes specific therapeutic interventions to be employed for resistance training. The weight, intensity, rest periods, frequency, and adequate selection of exercises are critical of muscle training.[12,13]

Translating these concepts to vocal training, the prescription of vocal exercises should include four basic parameters: frequency, duration, intensity, and progression.[14]

With regard to duration, the time required to induce vocal and laryngeal changes after exercise may vary between patients and be sex-dependent. Prior studies suggested that optimal auditory-perceptual and acoustic parameters occurred during the first 3 minutes of Voiced Tongue Vibration Exercises in a normophonic females, and during the first 5 minutes for both sexes with vocal nodules.[15–17]

One study[18] evaluated the effects of straw phonation exercises and noted that adult women with behavioral dysphonia improved based on self-evaluation by the third minute of exercise. Maximum phonation time (MPT) and F0 variability increased after the third and fifth minutes of straw phonation exercise, and after the seventh minute, worsening of these parameters was noted and thought to be related to fatigue.

Semi-occluded vocal tract exercises are commonly employed in vocal training. Straw phonation is an included exercise encompassed by this technique. The mechanisms underlying the favorable effects of these exercises are thought to be increased subglottic pressure and vocal tract impedance resulting in reduced glottal pressure.[19,20]

The main goal of this technique is to reduce phonatory effort and increase vocal efficiency. Increased subglottic pressure and decreased glottal pressure yield slight abduction of the vocal folds. This phenomenon establishes an ideal correspondence of impedance, reducing collision forces between the vocal folds and balancing source-filter interactions to improve vocal economy.[19–22]

Although studies have supported the favorable effects of straw phonation,[19,21,23,24] no literature provides a framework for the effects of these exercises in the pediatric population. Considering differential responses related to the variables presented previously, we sought to determine whether the duration of straw phonation exercises affected auditory perceptual or acoustic parameters in children with dysphonia.

METHODS

The present study was approved by the Committee of Ethics in Research (#334.400) and was a randomized, prospective, comparative intra-subject study. All enrolled subjects provided informed consent.

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This study was conducted at the Department of Speech-Language Pathology, Faculty of Medicine, Federal University of Minas Gerais—UFMG—Minas Gerais (MG).

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Twenty-seven children, ranging from 5 to 10 years of age (mean = 8.18 years, SD = 2.03) were enrolled in the current study. Twenty-five of these children presented with an otorhinolaryngological diagnosis of vocal fold nodules (95.59%) and two presented with an epidermoid cyst of the vocal fold (7.41%). Twenty-one subjects (77.78%) were male and six (22.22%) were female.

Otorhinolaryngological diagnosis was obtained by two otorhinolaryngologists via fibronasolaryngoscopic examination using a Machida ENT-30PIII laryngoscope (Japan) coupled to a Toshiba micro camera (Japan) and Alphatron light source (The Netherlands). Only subjects who were able to perform the exercises correctly were included.

Exclusion criteria were (1) inflammatory or allergic alterations at the time of evaluation, (2) severe dysphonia degree (G3 according to the Grade Roughness Breathiness Asthenia/Strain Instability scale), and (3) neurologic, auditory, or congenital conditions which could interfere with phonation. Subjects who had previously undergone speech therapy were also excluded.

An intra-subject comparative design was employed. As such, all subjects participated in both the Control Group (CG) and Experimental Group (EG). This design was selected to evaluate the effects of treatment versus non-treatment in the same subject. CG was defined as no treatment or placebo.[25] CG was completed within the same session as the experimental condition.

Initially, the subjects were subjected to the CG arm which involved complete vocal rest. During the intervention, the subjects were asked to play video games, but were not permitted to phonate. Voice samples were recorded before the CG condition as well as at the first (m1), the third (m3), the fifth (m5), and the seventh (m7) minutes of rest.

In the EG, subjects received a rigid plastic straw (8.7 cm of length and 1.5 mm of diameter) and after demonstration, they were oriented to conduct straw phonation exercises. This technique consists of blowing through a straw placed between the teeth and lips for a prolonged period of time while producing sound. The straw was placed in a manner that would allow respiratory air flow exit. Voice samples were recorded before (m0) exercise and after the first (m1), the third (m3), the fifth (m5), and the seventh (m7) minute of exercise. All voice samples were recorded with an Acer Aspire 4739–6886 computer (Taiwan) using *VoxMetria* (CTS.2.6, CTS Informática, Brazil) software and an unidirectional condenser microphone located diagonally 2 cm from the mouth. The directional capture angle was maintained at 45° in an acoustically treated room. Subjects produced the sustained vowels /a/ and /ɛ/ and counted from 1 to 10 using comfortable loudness and pitch.

Regarding auditory perceptual analysis, voice samples from both the EG and CG were randomized and presented to five different qualified speech-language pathologists with greater than 5 years of experience with auditory perceptual analysis of voice. Auditory perceptual analysis of voice was performed using the Voice's Auditory-Perceptual Analysis Protocol built specifically for paired analysis. This protocol has been described previously.[26] The edition of the sustained vowels and connected speech was made using the software *Sound Forge 6.0* (Sony, Japan). The voice samples from the EG and CG conditions as well as the time points were randomized and presented to the raters in pairs. The following comparisons were evaluated: m0-m1, m0-m3, m0-m5, m0-m7, m1-m3, m3-m5, and m5-m7. No raters had knowledge of treatment condition or time point.

For each pair of voice samples, the raters evaluated if the second voice was better, worse, or the same as the first. If a difference was reported, raters were then queried regarding the two auditory-perceptual parameters from the Grade Roughness Breathiness Asthenia/Strain Instability scale that most influenced this change.[27]

To determine the reliability between the evaluators, 20% of the voice samples were randomly repeated. Kappa coefficient of agreement was employed to quantify intra-evaluator concordance. From the five raters, one was noted to have high intra-subject concordance (80%).

The selected parameters for acoustic analysis extracted from sustained vowels were F0 in Hz, jitter in percentage, shimmer in percentage, glottal to noise excitation (GNE) ratio in decibel (dB), and noise in dB. These parameters were determined via VoxMetria (CTS Informática). Normalized values for these measures were taken from the software manual: F0 244 Hz,[16] jitter% between 0% and 0.6%, shimmer% between 0% and 6.5%, GNE equal or superior to 0.5 dB, and noise up to 2.5 dB.

For statistical analysis, a chi-square test, Fisher exact test, *t* test, and analysis of variance were conducted using *SPSS 18.0* (*Statistical Package for the Social Sciences*) (IBM, USA). To compare acoustic parameters, the analysis of variance test for continuous variables was performed. Because no statistical significance was noted, a Bonferroni correction was not necessary to verify statistically significant differences between groups. The alpha level was 0.05 (5%).

RESULTS

In the EG, auditory perceptual analysis of voice did not yield differences between time points (Table 1).

Similarly, in the CG, no voice changes were observed across time points (Table 2).

When comparing the two groups, improved vocal quality was observed after 3 and 5 minutes of straw phonation (Table 3) in the EG. The auditory perceptual parameters that improved the most following exercise were vocal roughness (R) and breathiness (B), and after the fifth minute, breathiness (B) and the grade of dysphonia (G).

Acoustic analyses of both CG (Table 4) and EG (Table 5) did not reveal differences between groups with regard to the means of each measure as a function of time point.

When the acoustic parameters between CG and EG were compared, GNE increased and noise decreased after the third minute of straw phonation (Table 6).

DISCUSSION

Similar to our sample, the prevalence of dysphonia in male children ranging from 4 to 13 years old is quite high (53%), with vocal fold nodules as the most prevalent lesion (53%).[28] According to previous work, the incidence of nodules in boys peaks from the seventh to the ninth year of age, which also corresponds to increased social interactions. The increase of lesions